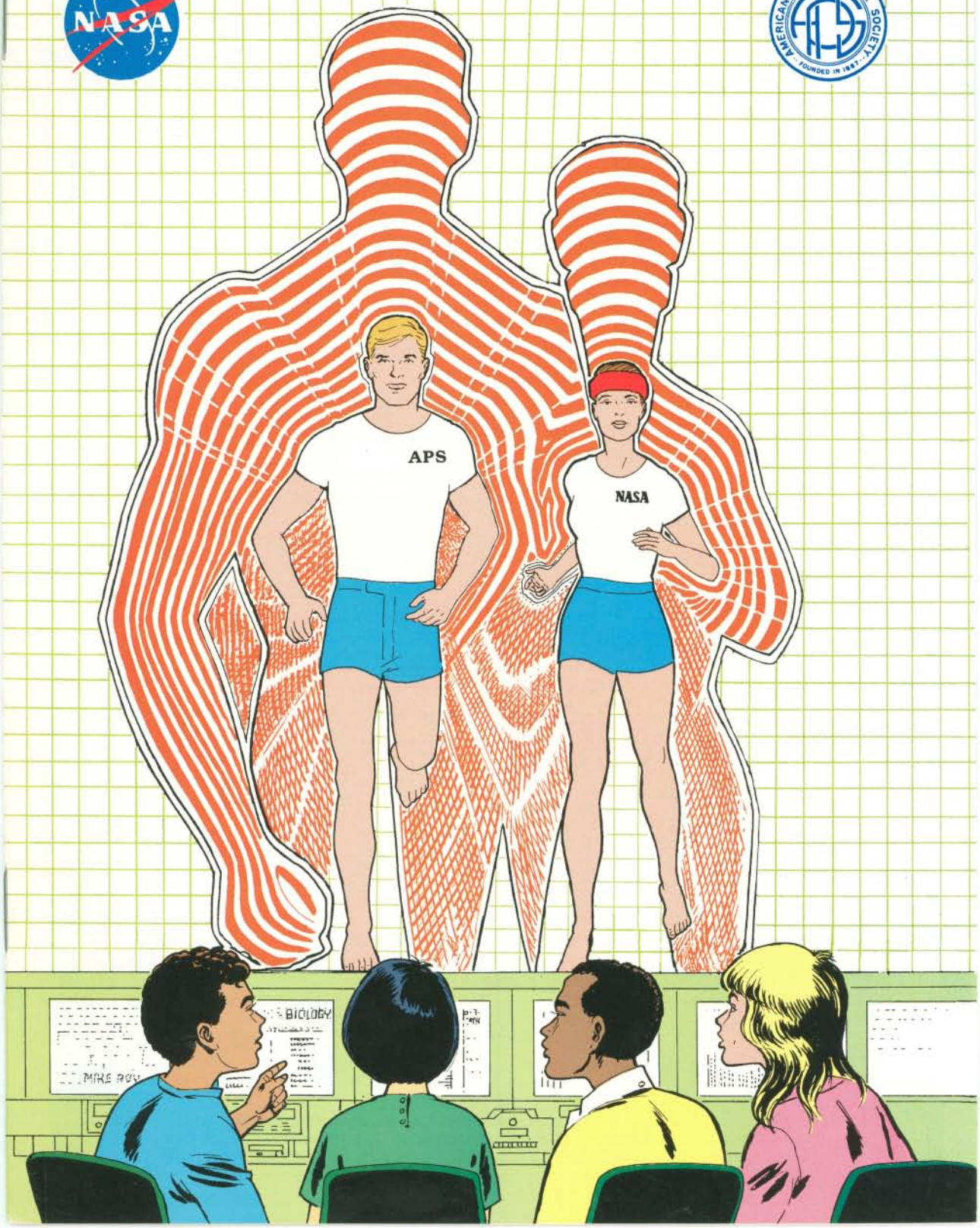
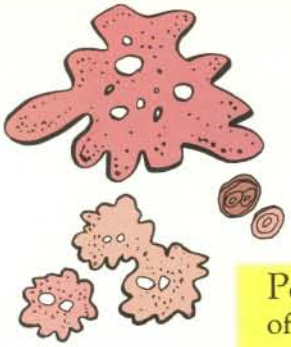
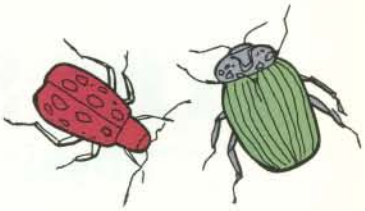
The Science of Life

Physiology Research in Action

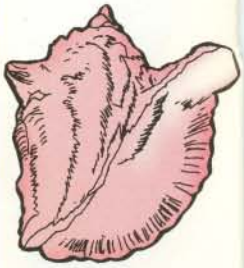




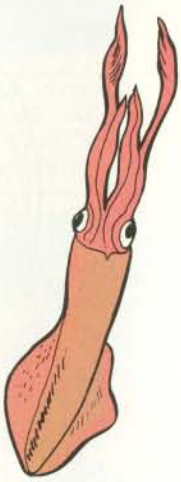


People have always been fascinated by the mysteries of life. Did you ever wonder...

How does your body work?
Why do you get sick and then better?
How do the medicines you take affect different parts of your body?
How can studying animals, on earth and in space, make our lives longer and healthier?



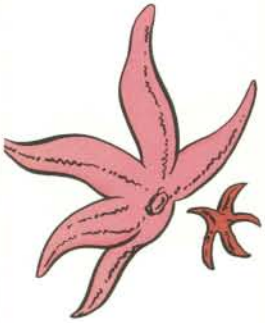
Physiology is the science of living systems. Physiologists are scientists who study life processes in humans, animals and plants, and how our organ systems work together to keep us healthy.



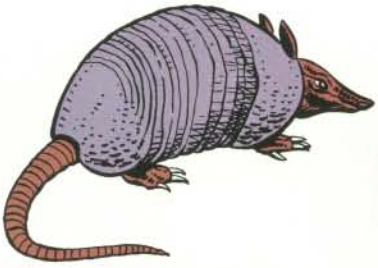
Physiology research has provided information that leads to healthier and longer lives for everyone. In fact, people and animals owe their lives to the discoveries made by physiologists.

Physiologists want to find answers to questions like ...

How does the body adjust to the conditions of space flight?
What factors limit an athlete's, scuba diver's, or astronaut's performance?
How do the cells in our bodies work together to keep us healthy?



As you read this book, you will learn how physiologists' work benefits people and animals. You'll also learn that physiologists have made our world a better place and that many mysteries still remain. Maybe you will choose to join the exploration of life's mysteries as a physiologist!



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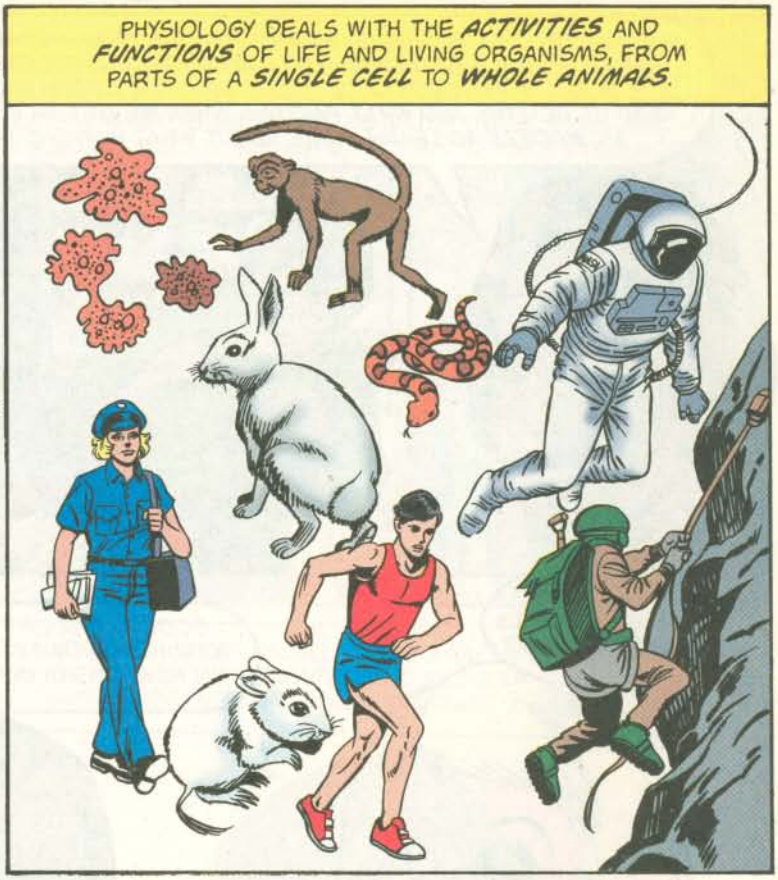
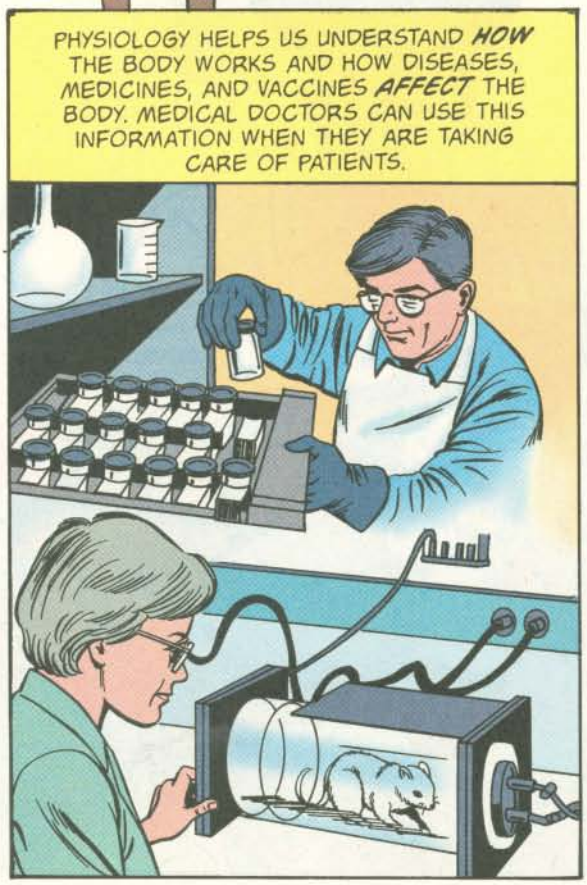
LOOK, CHRIS! A SUBSTITUTE TEACHER!
I HEARD MRS. TODD HAD HER BABY ALREADY.
SHE WASN'T SUPPOSED TO HAVE IT FOR ANOTHER MONTH.
HELLO, CLASS! I'M MRS. BARON -- I'LL BE YOUR SUBSTITUTE BIOLOGY TEACHER FOR THE REST OF THE SEMESTER.
BIOLOGY
DID OUR TEACHER HAVE HER BABY?
MRS. TODD'S BABY ISN'T READY TO BE BORN YET. SHE STARTED GOING INTO LABOR OVER THE WEEKEND SO HER DOCTOR SUGGESTED SHE TAKE IT EASY FOR THE NEXT FEW WEEKS.
MRS. TODD SAID SHE HAD DIABETES. IS THAT WHY THIS HAPPENED?
NOT REALLY. SOME PEOPLE HAVE DIABETES BECAUSE THEIR BODIES DON'T MAKE ENOUGH INSULIN, WHICH IS A CHEMICAL THAT HELPS THE CELLS IN YOUR BODY TAKE UP FOOD. OTHER PEOPLE BECOME DIABETIC BECAUSE THEIR BODIES CAN'T MAKE PROPER USE OF INSULIN. A FEW WOMEN, LIKE MRS. TODD, DEVELOP DIABETES WHILE THEY ARE PREGNANT. BUT DIABETES DIDN'T MAKE MRS. TODD'S LABOR START TOO EARLY.

HOW CAN HAVING A BABY MAKE YOU DEVELOP DIABETES?
WHEN A WOMAN IS PREGNANT, HER BODY MAKES SEVERAL CHEMICALS, CALLED HORMONES. THEY CAUSE HER BODY TO CHANGE AND HELP THE BABY TO GROW AND DEVELOP. THESE HORMONES ALL WORK AGAINST INSULIN, SO HER BODY HAS TO MAKE EVEN MORE INSULIN TO KEEP UP WITH WHAT SHE NEEDS. SOME WOMEN'S BODIES CAN'T DO THAT, AND THAT IS CALLED GESTATIONAL DIABETES.
WILL SHE BE OKAY?
THIS KIND OF DIABETES USUALLY GOES AWAY AFTER THE BABY IS BORN. WITH GOOD EATING HABITS AND REGULAR EXERCISE, SHE CAN MINIMIZE HER RISK OF DEVELOPING DIABETES LATER IN LIFE.
IS HER BABY GOING TO HAVE DIABETES?
CHILDREN AREN'T BORN WITH DIABETES, AND EVEN WHEN MOTHERS HAVE DIABETES DURING PREGNANCY, VERY FEW OF THEIR BABIES WOULD HAVE DIABETES WHEN THEY GROW UP.

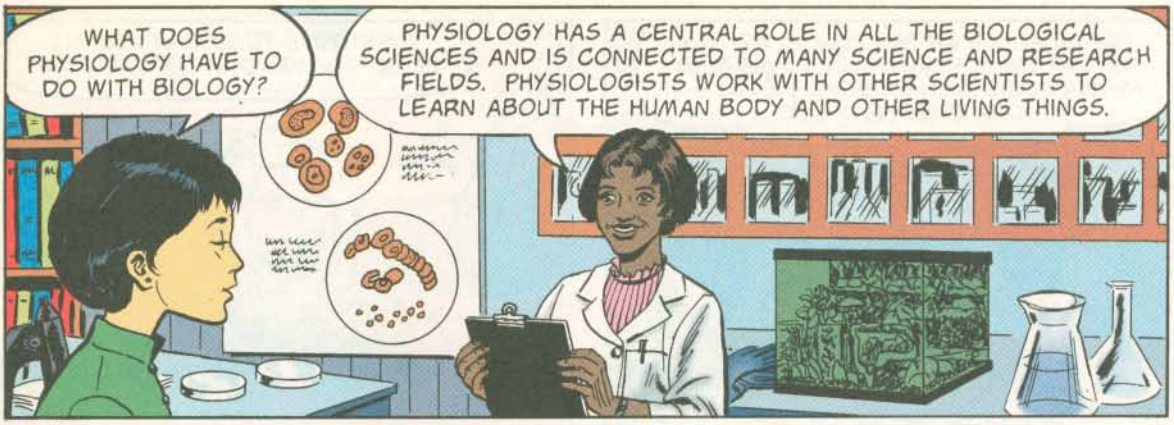
DURING THE LAST 20 YEARS, SCIENTISTS HAVE BEEN DOING RESEARCH WITH RATS AND OTHER ANIMALS TO UNDERSTAND HOW DIABETES AFFECTS THE ORGAN SYSTEMS OF THE BODY. PHYSIOLOGISTS STUDY HOW OUR ORGAN SYSTEMS WORK TOGETHER TO KEEP US HEALTHY, AND WHAT HAPPENS WHEN WE GET SICK. THEY OFTEN USE ANIMALS AS MODELS TO LEARN MORE ABOUT WHAT HAPPENS INSIDE THE HUMAN BODY.
MRS. BARON, WHAT'S A PHYSIOLOGIST?
GOOD QUESTION! THAT'S OUR TOPIC TODAY, AND YOUR HOMEWORK FOR THURSDAY IS TO DO A REPORT ON HOW PHYSIOLOGY RESEARCH TOUCHES OUR LIVES.
THAT'S A SNEAKY WAY TO GIVE OUT HOMEWORK!
KEEP QUIET -- SHE MIGHT GIVE US MORE!

PHYSIOLOGY IS THE STUDY OF LIFE AND HOW LIVING THINGS WORK.

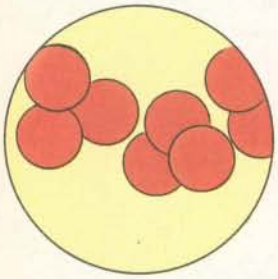

PHYSIOLOGY DEALS WITH THE ACTIVITIES AND FUNCTIONS OF LIFE AND LIVING ORGANISMS, FROM PARTS OF A SINGLE CELL TO WHOLE ANIMALS.


PHYSIOLOGY HELPS US UNDERSTAND HOW THE BODY WORKS AND HOW DISEASES, MEDICINES, AND VACCINES AFFECT THE BODY. MEDICAL DOCTORS CAN USE THIS INFORMATION WHEN THEY ARE TAKING CARE OF PATIENTS.

PHYSIOLOGY HELPS US UNDERSTAND WHAT "LIFE" IS AND HOW TO TREAT DISEASES. PHYSIOLOGY ALSO STUDIES HOW TO COPE WITH ENVIRONMENTAL STRESSES IMPOSED ON OUR BODIES, SUCH AS HEAT AND COLD, AND NEAR WEIGHTLESSNESS.



MOLECULAR BIOLOGY



BIOCHEMISTRY

BIOPHYSICS

CELL BIOLOGY

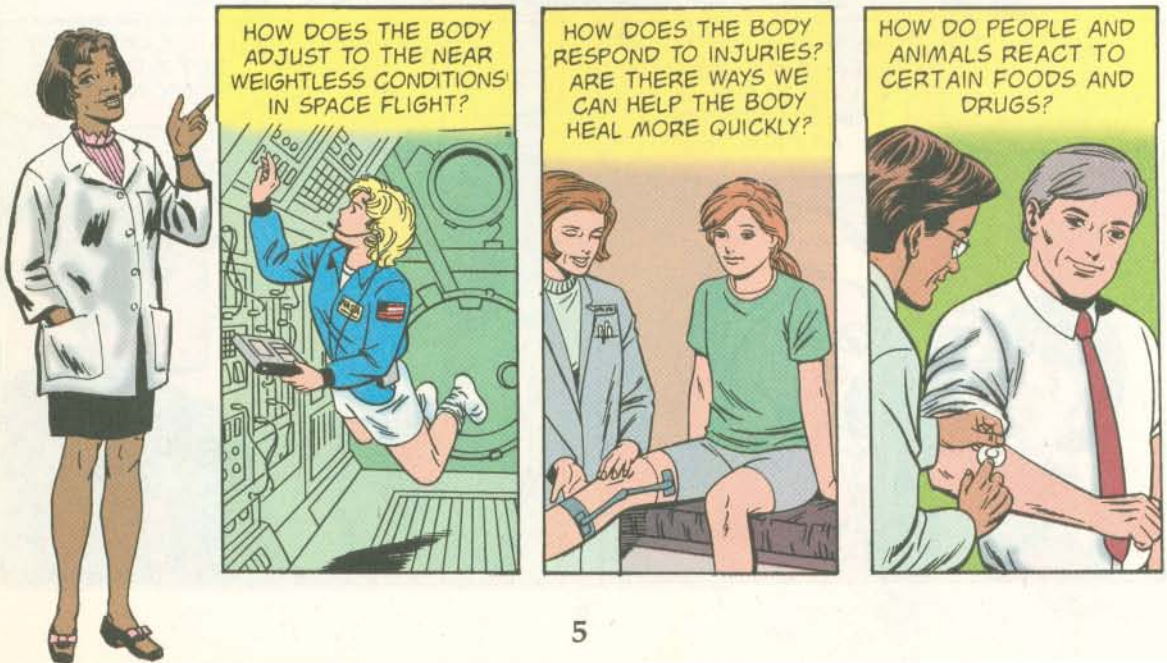
PHARMACOLOGY

MEDICAL SCIENCES

VETERINARY SCIENCES

GRAVITATIONAL AND SPACE BIOLOGY

PHYSIOLOGISTS WANT TO FIND OUT ANSWERS TO QUESTIONS LIKE.....



FOR YOUR HOMEWORK, PLEASE WRITE A REPORT ON HOW DISCOVERIES MADE BY PHYSIOLOGISTS HAVE BENEFITED YOU IN YOUR EVERYDAY LIFE.

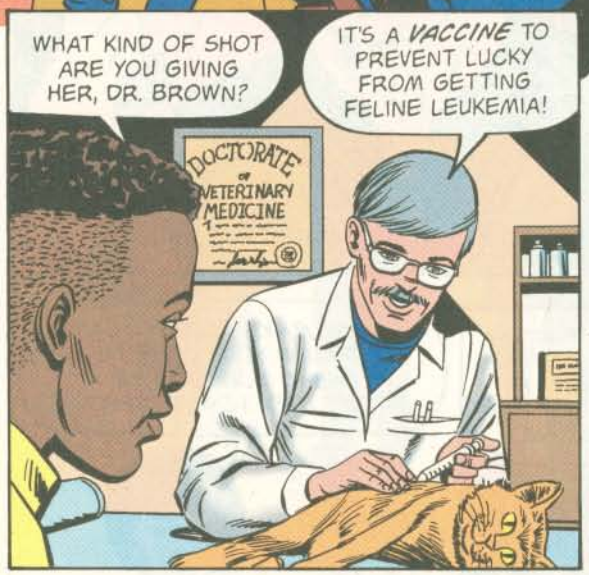
SUBSTITUTE TEACHERS ARE ALL ALIKE -- HOMEWORK THE FIRST DAY!

WHERE AM I GOING TO FIND OUT MORE ABOUT PHYSIOLOGY?
CHILL, GUYS. WE'LL GET IT DONE!

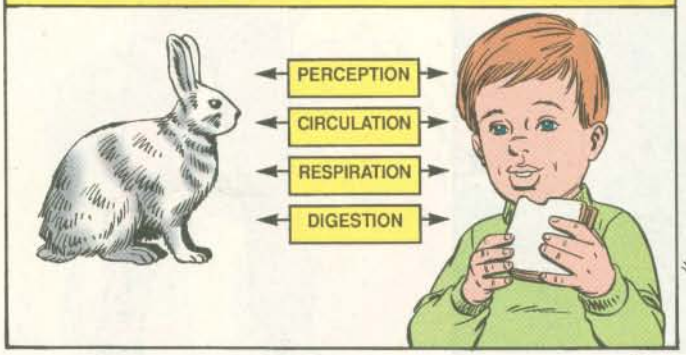
I HAVE TRACK PRACTICE TODAY -- WHAT'S UP WITH YOU?
SHOPPING! I NEED SOME NEW MAKE-UP AND I HAVE TO PICK UP A PRESCRIPTION FOR MY GRANDMOTHER!

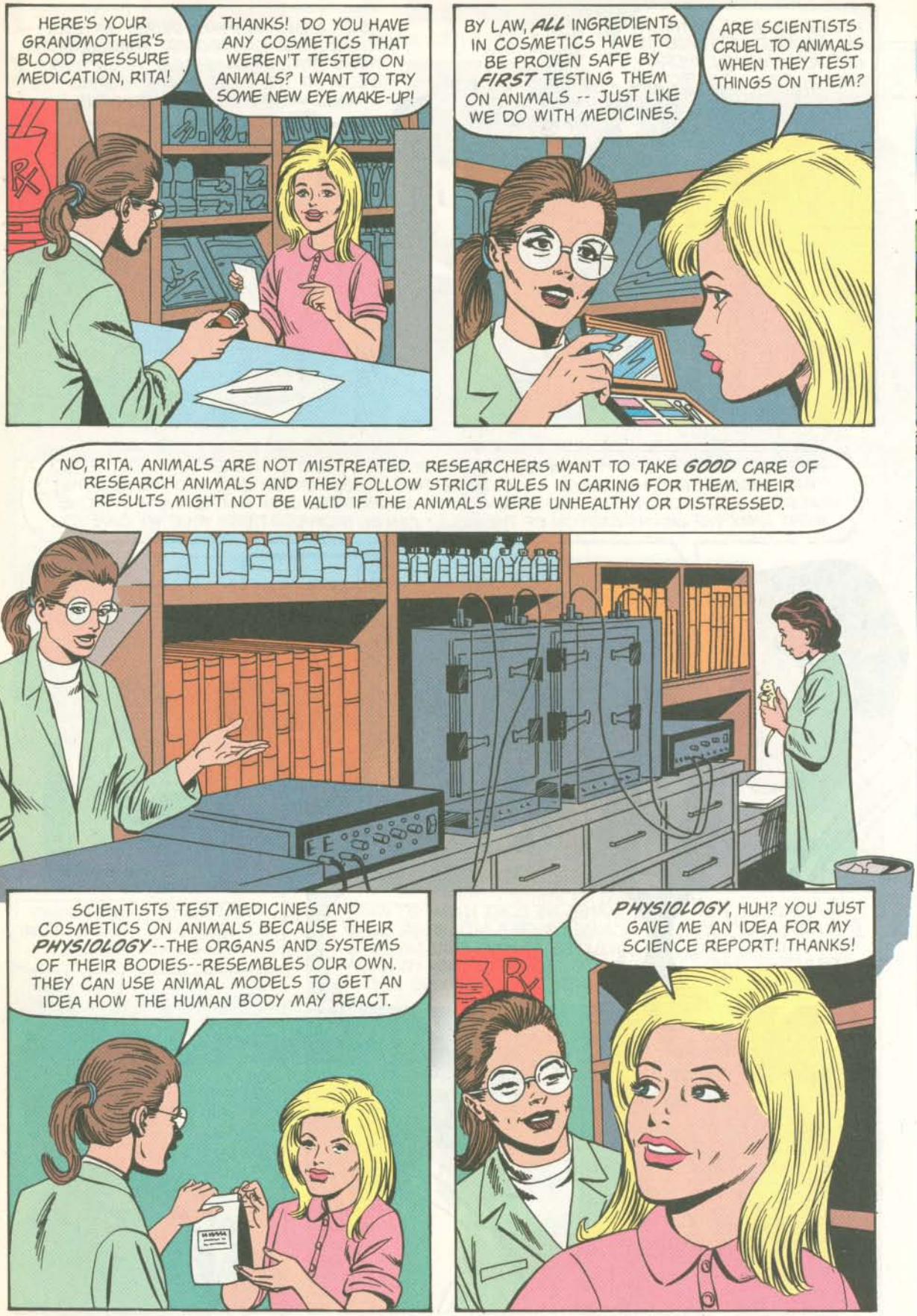
SEE YOU TOMORROW, DAVID!
LATER, CHRIS! I'VE GOT A DOCTOR'S APPOINTMENT!

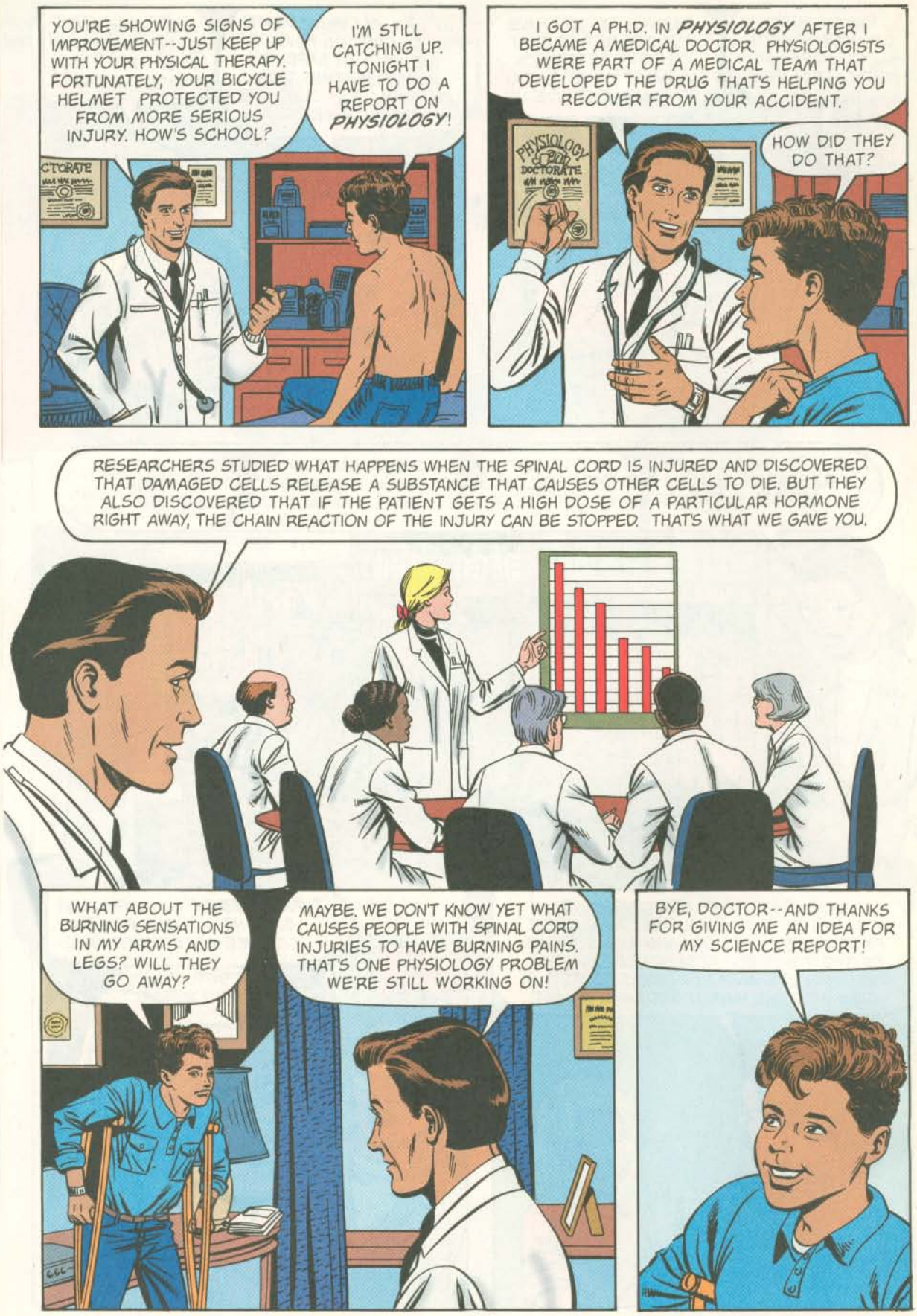
HOW'S YOUR KNEE TODAY, JOANNE?
BETTER, COACH--: I'M MORE CAREFUL ABOUT WORKING WITH MY BODY INSTEAD OF AGAINST IT! I DON'T WANT TO RUIN MY CHANCES OF BECOMING AN ASTRONAUT.
YOU'RE RIGHT--YOU'LL NEED TO BE IN TOP SHAPE TO BE AN ASTRONAUT CANDIDATE. ASTRONAUTS NEED TO STAY FIT. PHYSIOLOGISTS HAVE FOUND THAT OUR BODIES ACTUALLY WEAKEN IN SPACE.
WOW. DO YOU MEAN OUR MUSCLES GET WEAKER? HOW DO YOU KNOW THAT?
YES, OUR MUSCLES GET WEAKER AND A LOT OF OTHER CHANGES HAPPEN TOO. I JUST READ AN ARTICLE ABOUT SPACE PHYSIOLOGY IN ONE OF MY TEACHER JOURNALS.
SPACE PHYSIOLOGY! CAN I BORROW YOUR JOURNAL, COACH? YOU GAVE ME A GREAT IDEA FOR MY REPORT!



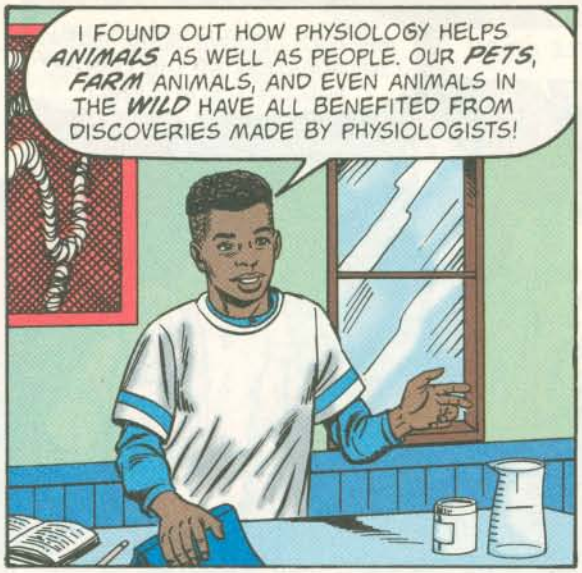
VACCINES MUST UNDERGO ***EXTENSIVE*** TESTING TO DETERMINE HOW WELL THEY WORK. RESEARCHERS LOOK CAREFULLY AT WHAT A MEDICATION DOES TO ALL PARTS OF THE BODY, AND ***PHYSIOLOGY*** IS THE STUDY OF HOW THE BODY'S ORGANS AND SYSTEMS WORK. DEVELOPING A VACCINE REQUIRES MUCH RESEARCH AND TESTING WITH ***ANIMALS*** AND ***HUMANS*** AND INVOLVES RESEARCHERS FROM SEVERAL FIELDS.

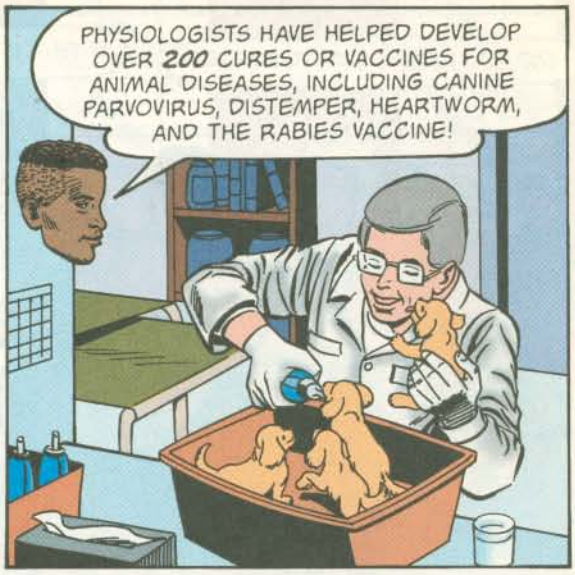



HERE'S YOUR GRANDMOTHER'S BLOOD PRESSURE MEDICATION, RITA!
THANKS! DO YOU HAVE ANY COSMETICS THAT WEREN'T TESTED ON ANIMALS? I WANT TO TRY SOME NEW EYE MAKE-UP!
BY LAW, ALL INGREDIENTS IN COSMETICS HAVE TO BE PROVEN SAFE BY FIRST TESTING THEM ON ANIMALS -- JUST LIKE WE DO WITH MEDICINES.
ARE SCIENTISTS CRUEL TO ANIMALS WHEN THEY TEST THINGS ON THEM?
NO, RITA. ANIMALS ARE NOT MISTREATED. RESEARCHERS WANT TO TAKE GOOD CARE OF RESEARCH ANIMALS AND THEY FOLLOW STRICT RULES IN CARING FOR THEM. THEIR RESULTS MIGHT NOT BE VALID IF THE ANIMALS WERE UNHEALTHY OR DISTRESSED.
SCIENTISTS TEST MEDICINES AND COSMETICS ON ANIMALS BECAUSE THEIR PHYSIOLOGY--THE ORGANS AND SYSTEMS OF THEIR BODIES--RESEMBLES OUR OWN. THEY CAN USE ANIMAL MODELS TO GET AN IDEA HOW THE HUMAN BODY MAY REACT.
PHYSIOLOGY, HUH? YOU JUST GAVE ME AN IDEA FOR MY SCIENCE REPORT! THANKS!

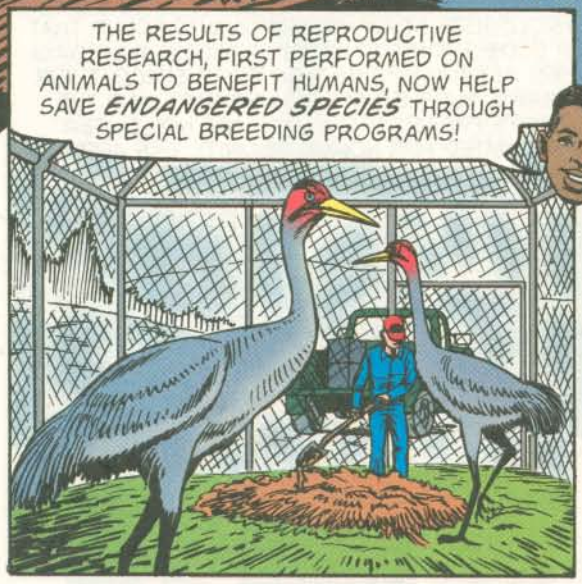

YOU'RE SHOWING SIGNS OF IMPROVEMENT--JUST KEEP UP WITH YOUR PHYSICAL THERAPY. FORTUNATELY, YOUR BICYCLE HELMET PROTECTED YOU FROM MORE SERIOUS INJURY. HOW'S SCHOOL?
I'M STILL CATCHING UP. TONIGHT I HAVE TO DO A REPORT ON PHYSIOLOGY!
I GOT A PH.D. IN PHYSIOLOGY AFTER I BECAME A MEDICAL DOCTOR. PHYSIOLOGISTS WERE PART OF A MEDICAL TEAM THAT DEVELOPED THE DRUG THAT'S HELPING YOU RECOVER FROM YOUR ACCIDENT.
PHYSIOLOGY DOCTORATE
HOW DID THEY DO THAT?
RESEARCHERS STUDIED WHAT HAPPENS WHEN THE SPINAL CORD IS INJURED AND DISCOVERED THAT DAMAGED CELLS RELEASE A SUBSTANCE THAT CAUSES OTHER CELLS TO DIE. BUT THEY ALSO DISCOVERED THAT IF THE PATIENT GETS A HIGH DOSE OF A PARTICULAR HORMONE RIGHT AWAY, THE CHAIN REACTION OF THE INJURY CAN BE STOPPED. THAT'S WHAT WE GAVE YOU.
WHAT ABOUT THE BURNING SENSATIONS IN MY ARMS AND LEGS? WILL THEY GO AWAY?
MAYBE. WE DON'T KNOW YET WHAT CAUSES PEOPLE WITH SPINAL CORD INJURIES TO HAVE BURNING PAINS. THAT'S ONE PHYSIOLOGY PROBLEM WE'RE STILL WORKING ON!
BYE, DOCTOR--AND THANKS FOR GIVING ME AN IDEA FOR MY SCIENCE REPORT!

DID YOU FINISH YOUR REPORTS?
WITH A LITTLE HELP!
ME, TOO! I FOUND SOME GREAT INFORMATION AT THE LIBRARY AND ON THE INTERNET.
BEFORE WE BEGIN, I WANT TO ANNOUNCE THAT MRS. TODD HAD A LITTLE GIRL YESTERDAY AND BOTH ARE FINE! NOW LET'S START OUR REPORTS WITH JOANNE.
I FOUND OUT THAT RESEARCH BY PHYSIOLOGISTS HAS HELPED ASTRONAUTS STAY HEALTHY AND IMPROVE THEIR PERFORMANCE WHILE WORKING IN SPACE!
PHYSIOLOGISTS STUDY WHAT HAPPENS TO THE HEART, LUNGS, BLOOD, AND MUSCLES WHEN AN ASTRONAUT IS IN SPACE. THEY FOUND, IN MICRO-GRAVITY, OUR BODY WORKS VERY DIFFERENTLY.
PHYSIOLOGISTS STUDYING ASTRONAUTS FOUND THAT OUR BODIES ADAPT TO MICROGRAVITY IN MANY WAYS. WHEN ASTRONAUTS RETURN FROM SPACE, THEIR BRAINS, MUSCLES, EYES, INNER EARS, AND THE BODY'S PRESSURE SENSORS ARE NO LONGER COORDINATED FOR NORMAL GRAVITY. THIS AFFECTS THEIR BALANCE AND THEY HAVE TROUBLE WALKING DURING THE FIRST FEW HOURS AFTER LANDING.

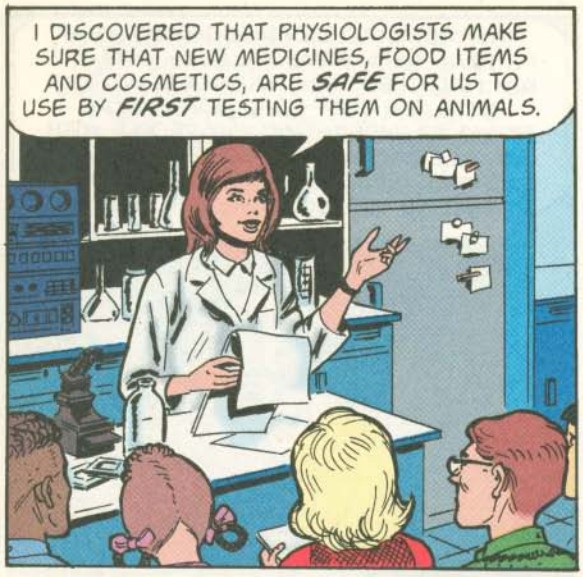

I FOUND OUT HOW PHYSIOLOGY HELPS ANIMALS AS WELL AS PEOPLE. OUR PETS, FARM ANIMALS, AND EVEN ANIMALS IN THE WILD HAVE ALL BENEFITED FROM DISCOVERIES MADE BY PHYSIOLOGISTS!

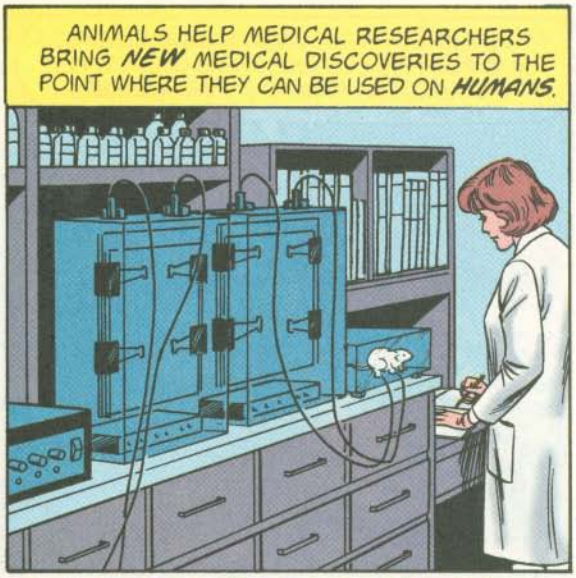

PHYSIOLOGISTS HAVE HELPED DEVELOP OVER 200 CURES OR VACCINES FOR ANIMAL DISEASES, INCLUDING CANINE PARVOVIRUS, DISTEMPER, HEARTWORM, AND THE RABIES VACCINE!

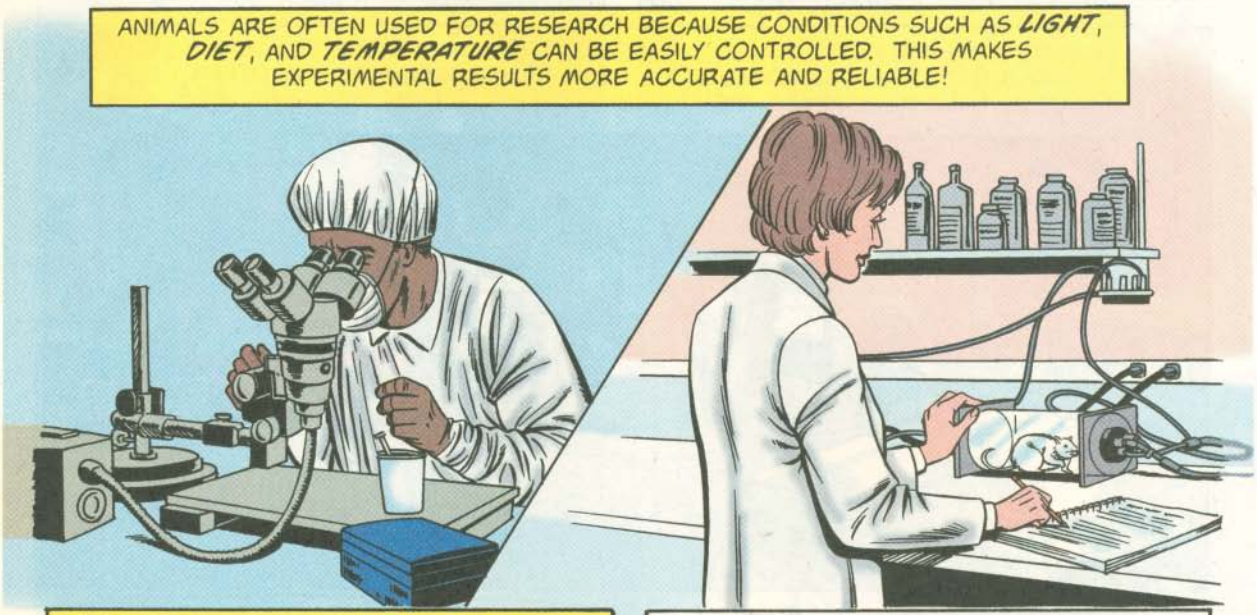
CHIMPANZEES THREATENED BY A POLIO EPIDEMIC WERE SAVED BY PUTTING A VACCINE INTO THEIR FOOD. THIS VACCINE WAS FIRST DEVELOPED TO SAVE HUMAN LIVES.

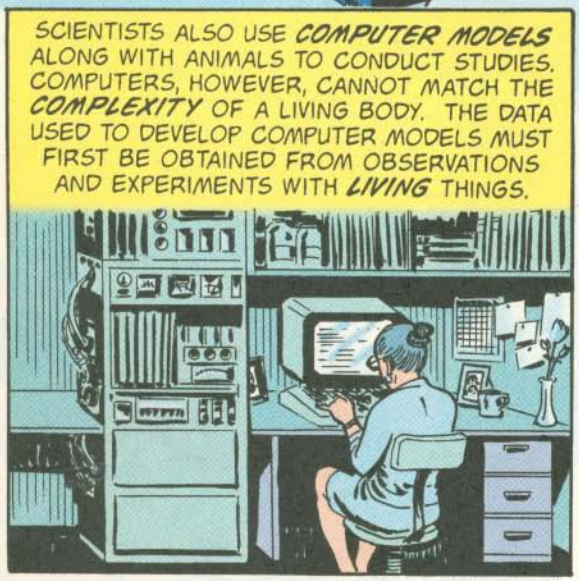

THE RESULTS OF REPRODUCTIVE RESEARCH, FIRST PERFORMED ON ANIMALS TO BENEFIT HUMANS, NOW HELP SAVE ENDANGERED SPECIES THROUGH SPECIAL BREEDING PROGRAMS!

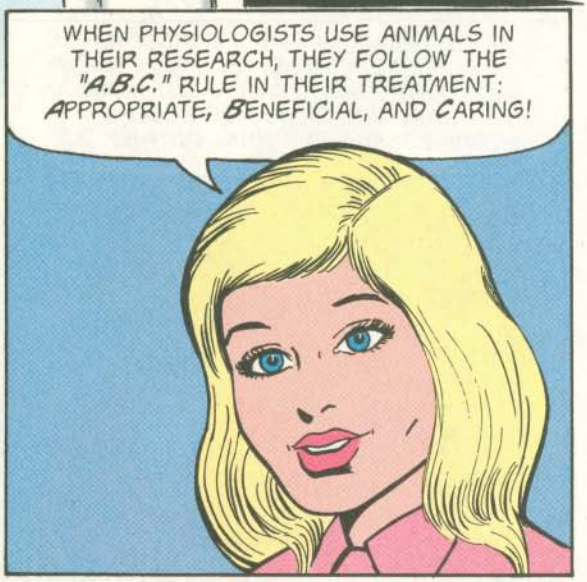
PHYSIOLOGISTS HELPED DEVELOP MEDICAL TREATMENTS, LIKE HEART PACEMAKERS AND ARTIFICIAL HIP JOINTS, WHICH ARE NOW DONE FOR ANIMALS AS WELL AS PEOPLE!

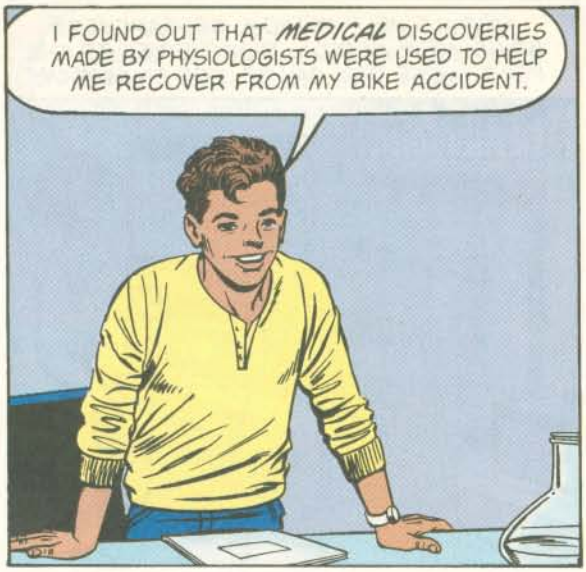

I DISCOVERED THAT PHYSIOLOGISTS MAKE SURE THAT NEW MEDICINES, FOOD ITEMS AND COSMETICS, ARE SAFE FOR US TO USE BY FIRST TESTING THEM ON ANIMALS.

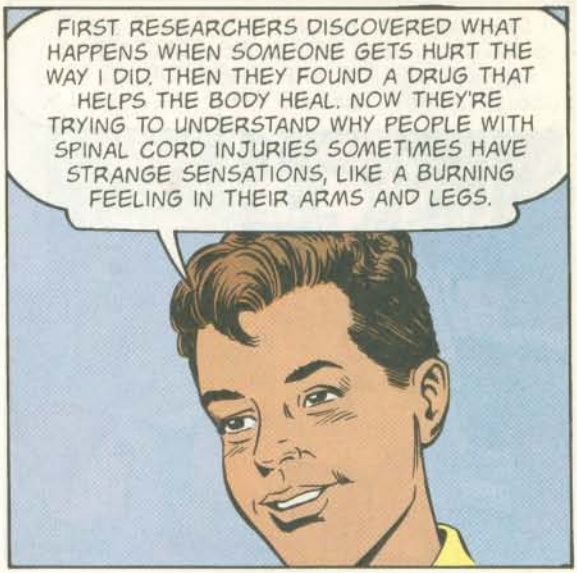

ANIMALS HELP MEDICAL RESEARCHERS BRING NEW MEDICAL DISCOVERIES TO THE POINT WHERE THEY CAN BE USED ON HUMANS.


ANIMALS ARE OFTEN USED FOR RESEARCH BECAUSE CONDITIONS SUCH AS LIGHT, DIET, AND TEMPERATURE CAN BE EASILY CONTROLLED. THIS MAKES EXPERIMENTAL RESULTS MORE ACCURATE AND RELIABLE!


SCIENTISTS ALSO USE COMPUTER MODELS ALONG WITH ANIMALS TO CONDUCT STUDIES. COMPUTERS, HOWEVER, CANNOT MATCH THE COMPLEXITY OF A LIVING BODY. THE DATA USED TO DEVELOP COMPUTER MODELS MUST FIRST BE OBTAINED FROM OBSERVATIONS AND EXPERIMENTS WITH LIVING THINGS.


WHEN PHYSIOLOGISTS USE ANIMALS IN THEIR RESEARCH, THEY FOLLOW THE "A.B.C." RULE IN THEIR TREATMENT: APPROPRIATE, BENEFICIAL, AND CARING!

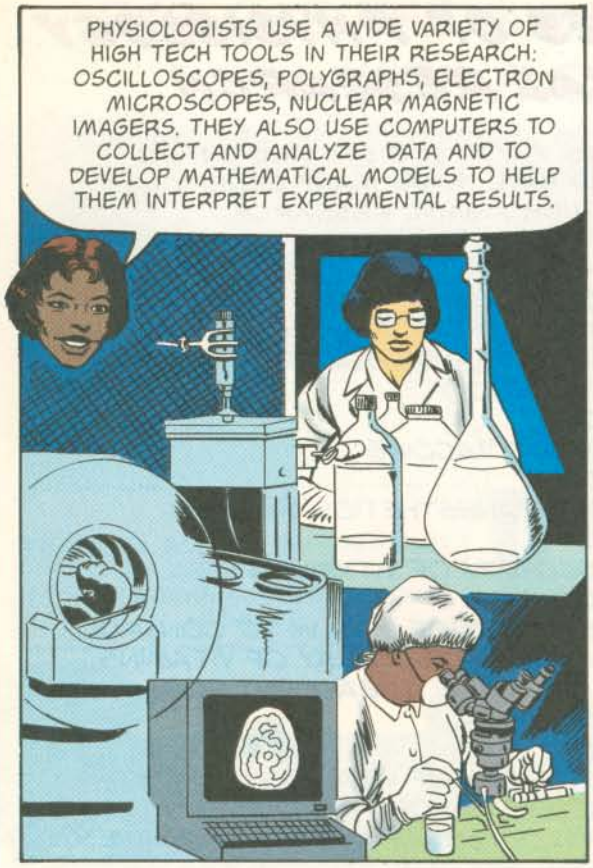

I FOUND OUT THAT *MEDICAL* DISCOVERIES MADE BY PHYSIOLOGISTS WERE USED TO HELP ME RECOVER FROM MY BIKE ACCIDENT.


FIRST RESEARCHERS DISCOVERED WHAT HAPPENS WHEN SOMEONE GETS HURT THE WAY I DID. THEN THEY FOUND A DRUG THAT HELPS THE BODY HEAL. NOW THEY'RE TRYING TO UNDERSTAND WHY PEOPLE WITH SPINAL CORD INJURIES SOMETIMES HAVE STRANGE SENSATIONS, LIKE A BURNING FEELING IN THEIR ARMS AND LEGS.

PHYSIOLOGISTS ARE PART OF RESEARCH TEAMS, ALONG WITH OTHER BIOLOGISTS, STUDYING DIABETES, HEART DISEASE, HIGH BLOOD PRESSURE, AND MANY OTHER DISEASES. THEIR DISCOVERIES ARE HELPING US TO LIVE LONGER, HEALTHIER LIVES.
CUTLERY & BAKERY
BAKERY

AFTER LEARNING HOW THE DISCOVERIES OF PHYSIOLOGISTS HELPED ME AFTER MY ACCIDENT, I WANT TO FIND OUT MORE -- WHAT KIND OF PEOPLE BECOME PHYSIOLOGISTS AND WHAT DO THEY DO?

THANKS, DAVID! PHYSIOLOGISTS COME FROM MANY *DIFFERENT* BACKGROUNDS AND FIELDS. WHAT THEY HAVE IN COMMON IS THEY WANT TO LEARN ABOUT LIFE PROCESSES SO THEY CAN *HELP* PEOPLE AND ANIMALS, *PREVENT* SUFFERING AND DISEASE, AND MAKE THE WORLD A *BETTER* PLACE TO LIVE.


PHYSIOLOGISTS USE A WIDE VARIETY OF HIGH TECH TOOLS IN THEIR RESEARCH: OSCILLOSCOPES, POLYGRAPHS, ELECTRON MICROSCOPES, NUCLEAR MAGNETIC IMAGERS. THEY ALSO USE COMPUTERS TO COLLECT AND ANALYZE DATA AND TO DEVELOP MATHEMATICAL MODELS TO HELP THEM INTERPRET EXPERIMENTAL RESULTS.

PHYSIOLOGISTS WORK IN LABORATORIES AND LIBRARIES, AND IN HOSPITALS AND CLINICS WITH SICK AND HEALTHY PEOPLE. PHYSIOLOGISTS ALSO STUDY THE FRONTIERS OF LIFE, FROM THE FAR REACHES OF THE EARTH AND EVEN INTO SPACE!

IF YOU DECIDE TO BECOME A PHYSIOLOGIST, THERE ARE MANY CAREERS YOU CAN CHOOSE IN SCIENCE, MEDICINE, RESEARCH, AND TEACHING. YOU MAY JOIN A TEAM OF SCIENTISTS WHO DISCOVER THE KEY TO A CRITICAL DISEASE IN THE FUTURE!

SO -- WHAT KIND OF PEOPLE BECOME PHYSIOLOGISTS? MAYBE SOMEONE LIKE RITA, DAVID, CHRIS, JOANNE..... OR YOU!

MAJOR DISCOVERIES OF PHYSIOLOGY AND BIOMEDICAL RESEARCH

OVER THE LAST 100 YEARS, PHYSIOLOGISTS AND OTHER BIOMEDICAL RESEARCHERS HAVE MADE MANY BENEFICIAL DISCOVERIES THROUGH ANIMAL RESEARCH.

1800S

TREATMENT FOR RABIES, SMALLPOX, ANTHRAX, AND BERIBERI (A VITAMIN B DEFICIENCY)

1890S

TYPHOID VACCINE

1900S

LOCAL ANESTHETICS

1910S

DISCOVERY OF VITAMIN A

1920S

DISCOVERY OF INSULIN TO CONTROL DIABETES. DISCOVERY OF VITAMINS B1, B2, AND E. TREATMENT FOR DISTEMPER.

1930S

DISCOVERY OF VITAMINS D AND K. PREVENTION OF TETANUS. DEVELOPMENT OF MODERN ANAESTHESIA.

1940S

DISCOVERY OF FOLIC ACIDS. DIPHTHERIA VACCINE. PENICILLINS, ANTIBIOTICS, HORMONES, STEROIDS, ANTIHISTAMINES. TREATMENT OF RHEUMATOID ARTHRITIS. TREATMENT FOR WHOOPING COUGH.

1950S

PREVENTION OF POLIO. DISCOVERY OF TRANQUILIZERS. DISCOVERY OF DNA. DEVELOPMENT OF OPEN HEART SURGERY AND CARDIAC PACEMAKER. DEVELOPMENT OF CANCER CHEMOTHERAPY.

1960S

PREVENTION OF RUBELLA. DEVELOPMENT OF ANTIPSYCHOTIC AND ANTIDEPRESSANT DRUGS.

1970S

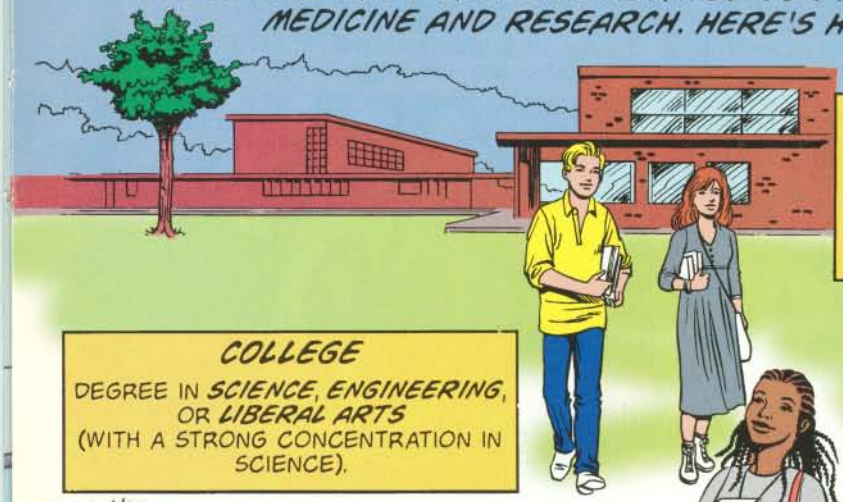
TREATMENT FOR GASTRIC ULCERS, LEPROSY. PREVENTION OF MEASLES. ADVANCES IN HEART TRANSPLANT SURGERY AND BYPASS OPERATIONS.

1980S-NOW

ORGAN TRANSPLANT TECHNIQUES. DEVELOPMENT OF GENE THERAPY AND REPLACEMENT. NEW STUDIES ON ALZHEIMER'S DISEASE AND THE ROLE OF VIRUSES IN AIDS.

EXPLORE THE MYSTERIES OF LIFE . . . WITH A CAREER IN PHYSIOLOGY

THERE ARE MANY CAREERS RELATED TO PHYSIOLOGY IN SCIENCE, MEDICINE AND RESEARCH. HERE'S HOW TO START!



HIGH SCHOOL

GET A STRONG BACKGROUND IN ***SCIENCE*** (BIOLOGY, CHEMISTRY, PHYSICS), ***MATH*** (ALGEBRA, GEOMETRY, TRIGONOMETRY, CALCULUS), AND ***ENGLISH.***

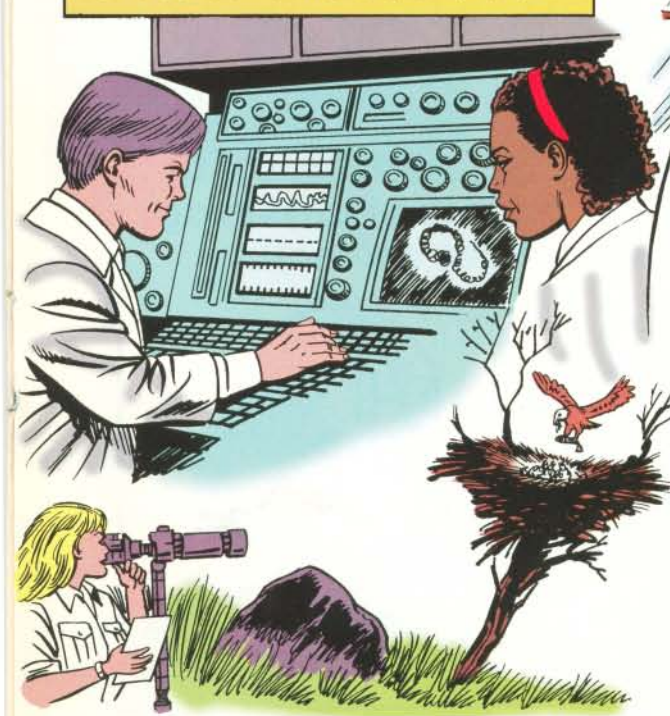
COLLEGE

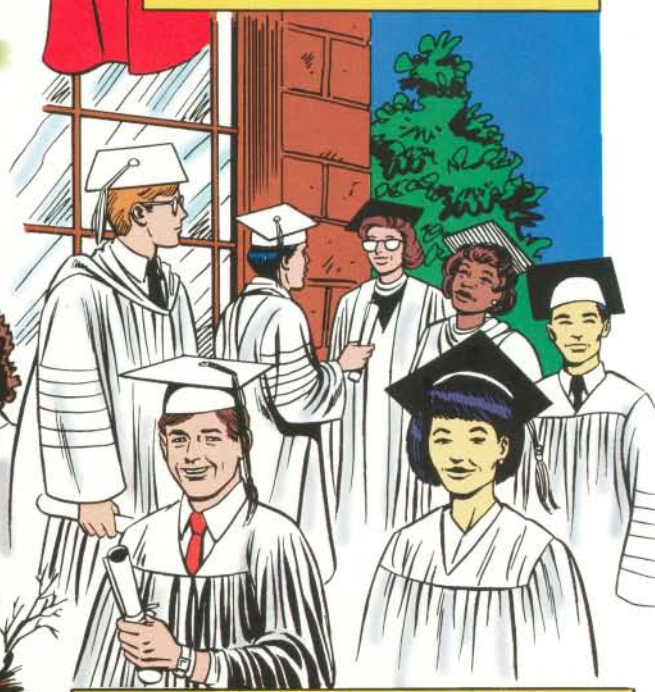
DEGREE IN ***SCIENCE, ENGINEERING,*** OR ***LIBERAL ARTS*** (WITH A STRONG CONCENTRATION IN SCIENCE).

GRADUATE SCHOOL

MASTERS DEGREE, DOCTORAL (PH.D.), OR ***MEDICAL DEGREE*** (M.D.)

PHYSIOLOGISTS LEAD INTERESTING LIVES. THEY MAY LECTURE TO STUDENTS, COLLECT DATA IN LABORATORIES ON EARTH OR IN SPACE, CONDUCT FIELD STUDIES, AND DO RESEARCH WHICH THEY SHARE WITH OTHER SCIENTISTS AT MEETINGS IN THE U.S. AND ABROAD.





PHYSIOLOGISTS CAN EARN EXCELLENT SALARIES AND HAVE SECURE JOBS, BUT THEIR GREATEST REWARD IS FROM HELPING ALL LIVING THINGS! AS A PHYSIOLOGIST, YOU MIGHT HELP HUMANS AND ANIMALS BY DISCOVERING A CURE FOR DISEASE, IMPROVING PUBLIC HEALTH, EXPLORING THE SOLAR SYSTEM, AND INCREASING THE QUALITY OF LIFE!

PHYSIOLOGY
PAST, PRESENT, AND FUTURE

For more information about the science of physiology and career opportunities, please contact:

Education Office
The American Physiology Society
9650 Rockville Pike
Bethesda, MD 20814-3991
email: educatio@aps.faseb.org

Space Life Sciences Outreach Office
Mail Stop 19-15
NASA Ames Research Center
Moffett Field, CA 94035

National Aeronautics and Space Administration